

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : <b>E21B 21/06, B01D 21/02</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 99/31347</b></p> <p>(43) International Publication Date: 24 June 1999 (24.06.99)</p>
<p>(21) International Application Number: PCT/NO98/00355</p> <p>(22) International Filing Date: 2 December 1998 (02.12.98)</p> <p>(30) Priority Data: 19975590 3 December 1997 (03.12.97) NO</p> <p>(71) Applicant (for all designated States except US): ABB RESEARCH LTD. [NO/NO]; c/o ABB Teknologiskole, Postboks 90, N-1361 Billingstad (NO).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): BRINGEDAL, Bjørn, Øyvind [NO/NO]; Flesåsveien 9, N-0860 Oslo (NO). HAUGEN, Knut [NO/NO]; Wilhelm Faerdens vei 4a, N-0361 Oslo (NO).</p> <p>(74) Agent: OSLO PATENTKONTOR AS; Postboks 7007 M, N-0306 Oslo (NO).</p>		<p>(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report. In English translation (filed in Norwegian).</p>
<p>(54) Title: ARRANGEMENT IN A SEPARATOR</p> <p>(57) Abstract</p> <p>The present invention relates to an arrangement in a separator, especially a gravity separator (1), to which separator is supplied with well fluid containing sand, and to avoid sand settling on walls of pipes or separators; it is according to the invention, suggested that the separator (1) comprises a conical part (5), which passes into a sloping or mainly vertical arranged bottom pipe (7), for, so to speak, continuous bottom outlet of sand (6), which is suspended in a fluid, mainly sand carrying water.</p>		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

**ARRANGEMENT IN A SEPARATOR****Field of invention**

- 5 The current invention relates to an arrangement in a separator, in particular a gravity separator, to which separator is supplied well fluid containing sand.

**Background of invention**

10

- The invention primarily aims at giving instructions on a technique where accumulation of sand in a gravity separator is avoided. The sand entering the separator with the main stream from, e.g. a production well, tend to settle  
15 on pipe or separator walls. Such sand sediments can be difficult to remove due to adhesive and cohesive forces.

**Prior art**

- 20 From the patent literature the problem named above concerning accumulation of sand in a gravity separator, seems not to be given particular attention. There exist a number of methods that deals with other types of separators, e.g. cyclones through which are fed a continuous  
25 stream of fluid containing solid particles such that accumulation of sand is avoided, but not in connection with gravity separators.

- From NO patent 176 451 there is known a device for processing of well fluids from oil or gas wells on the sea-  
30 floor utilising a separate accumulation tank for solid components or particles, placed below a separator tank.

From the bottom of the separator tank to the top of the accumulation tank there is placed a mainly vertical connection pipe with a cut off valve, and when this cut off valve is closed, collected components or particles can be removed from the accumulation tank. In other words this relates to a successive collection of solid components or particles, and a successive emptying of the accumulation tank, respectively.

#### 10 Summary of the invention

An object of the present invention is to provide an arrangement in a gravity separator, where sand can be removed from the separator with simple means.

15

Another object of the invention relates to continuous removal of sand from the gravity separator and continuous removal of the precipitated sand from the area of the separator.

20

Still another object of the present invention relates to transferring the problem of sand sedimentation in a gravity separator to other sections of the installation comprising the gravity separator, where it is easier to handle this problem.

25

These objects are achieved in an arrangement as initially mentioned, which according to the invention is characterised in that the separator comprises a lower conical part that leads into an oblique or mainly vertically arranged bottom pipe for practically continuous release from the

30

bottom of sand entrained in water, mainly sand-carrying water.

Additional advantages and features of the present invention will appear from the following disclosure in connection with the appended drawings, as well as the appended claims.

#### Brief description of the drawings

10

Fig. 1 is a schematic sketch of a gravity separator, designed according to a general embodiment of the invention.

15 Fig. 2 is a schematic sketch of an embodiment of a gravity separator included in an installation of several production wells.

#### Disclosure of embodiments

20

In Fig. 1 there is shown a separator, in particular a gravity separator 1, which via a supply line 2 is supplied with well fluid comprising oil, gas, water and sand.

25

From the upper part of the separator there is drawn off a mainstream comprising oil and gas via a first outlet line 3, while there on a lower level is drawn off separated water from a second outlet line 4.

30

Below the second outlet line for water the gravity separator 1 designed with a lower conical part 5 acting as a

guide for sand 6 entrained in a surplus part of the separated water. The conical part 5 leads to a oblique or mainly vertical arranged bottom pipe 7 for practically continuous bottom outlet of sand entrained in or carried  
5 of the mentioned surplus part of the separated water.

The named bottom pipe 7 is preferably connected to a transport pipe 8, which on its other side can suitable be coupled to said first discharge pipe 3 for the main  
10 stream of oil and gas, respectively constitutes a extension of said pipe.

Consequently, the sand entrained (suspended) in water can be carried back to the well fluid, from which water has  
15 been separated, and which is being transported through pipes, where the velocity of flow is sufficient to hold the said entrained, and adapted for pig cleaning in an adequate way.

20 The coned part 5 at the bottom of the gravity separator 1 is arranged lower than the main outlet 4 for separated water, and the dimension on the bottom pipe 7 can be less than said main outlet 4 for the separated water.

25 On figure 2 there is schematically illustrated how a gravity separator according to the invention can adapt a system, where several wells are included. Here is the gravity separator signified with 101, the first supply pipe for oil, gas, water and sand is signified with 102,  
30 the first outlet line for a main stream of oil and gas is signified with 103, and the other outlet line for separated water is signified with 104. The gravity separator

101 is here also achieved with a coned party 105, which lead particles of sand 106 through a smaller bottom pipe 107 to a transport line 108, which in the shown embodiment is coupled to another supply line 109 via a suitable valve 110, which additional supply line 109 communicates with a multitude of wells 111A, 111B...111n with suitable valves 112 arranged therebetween.

On figure 2 it is in the supply line 102 illustrated a valve 103, and further it is by the embodiment on figure 2 shown a third outlet line 114 from the gravity separator 101, which outlet line 114 via a valve 115 can communicate with said transport line 108. With the aid of the first supply line 102 with a valve 112 and the third outlet line 102 with a valve 112 and the third outlet line 114 with valve 115 it can be achieved a flexible in and out feeding at the separator, for example dependent by the different components relative contents in the well fluid.

20

In other words, there is according to the invention given an instruction on a technique, which comprises the following steps:

- 25 1. The sand that enters with the main stream, is kept in suspension through and out of the separator to avoid sand settling on the walls of pipes or separators. This is to be done because sediments of sand can be hard to get off due to adhesion and cohesion forces.
- 30 2. A separator is being used with a conical shaped bottom, so that the sand will not settle on the wall, but



falls all the way down to the bottom, where the cone passes into a pipe and out off the separator.

3. Through this pipe fluid streams continuously with sand.

- 5 4. The pipe, which goes out from the cone in the bottom of the separator, slopes downwards to a pipe, where sand is not a problem, for example because pig cleaning can be done there or because the velocity of flow is sufficient to keep the sand suspended.

## C l a i m s

1. Arrangement in a separator, in particular a gravity separator (1), to which separator it is supplied well  
5 fluid (2) containing sand,  
c h a r a c t e r i z e d i n that the separator (1) comprises a coned part (5), which leads into a sloping or mainly vertical arranged bottom pipe (7), for so to speak continuously bottom outlet of sand (6), which is sus-  
10 pended in fluid, mainly sand carrying water.
2. Arrangement according to claim 1,  
c h a r a c t e r i z e d i n that said bottom pipe (7) is coupled to a transport pipe (8), for example a  
15 transport pipe for well fluid, from which water has been separated, and which eventually is adapted for cleaning with a cleaning pig.
3. Arrangement according to claim 1 or 2,  
20 c h a r a c t e r i z e d i n that said bottom pipe (7) is coupled to a transport pipe (8) for well fluid, which completely or partly is being supplied with well fluid (3), from which water has been separated, from the same separator (1).
- 25 4. Arrangement according to one of the claims 1-3,  
c h a r a c t e r i z e d i n that the conical part (5) is arranged lower on the separator (1) than a main outlet (4) for separated water, and that the dimension of  
30 the bottom pipe (7) is smaller than said main outlet (4) for water.

5. Arrangement as claimed in one of the preceding claims,  
c h a r a c t e r i z e d   i n   that one or several  
separators (1) with said conical part (5) and sand outlet  
5 line (7) is being coupled to a supply line (109), which  
communicates with several wells (101a, 101b...101n).

Fig.1.

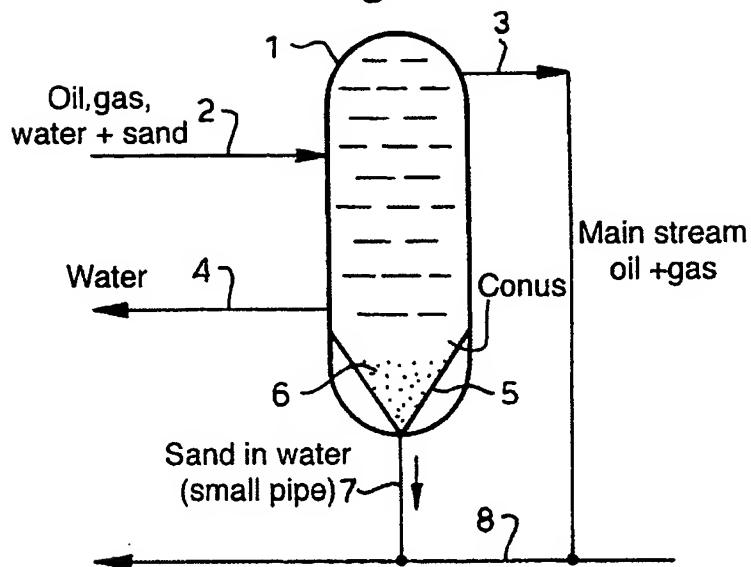
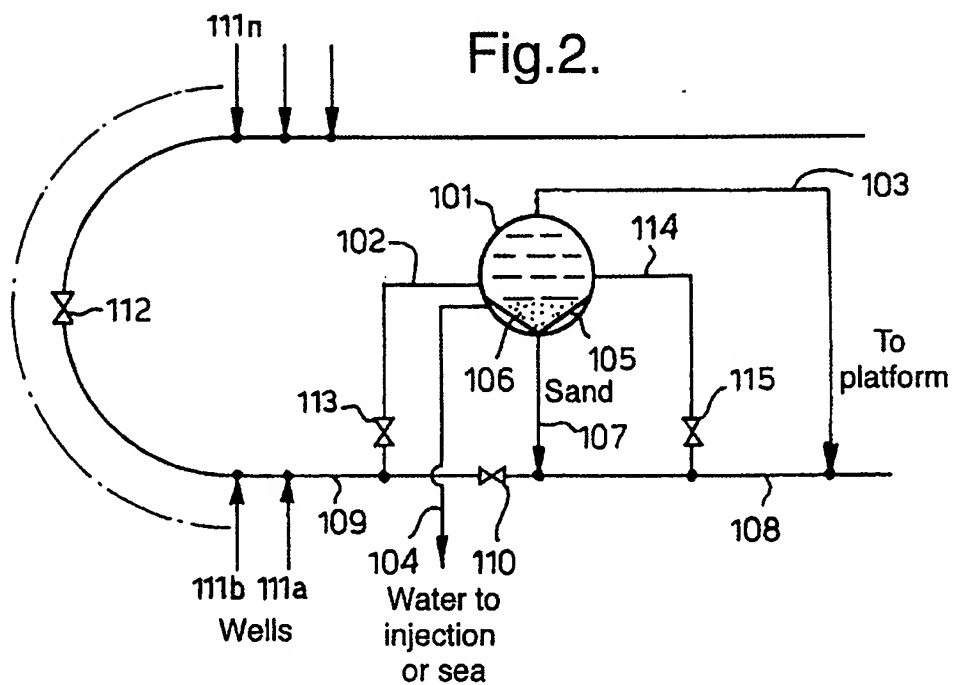


Fig.2.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 98/00355

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 21/06, B01D 21/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E21B, B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9718025 A1 (HANSEN, A. ET AL), 22 May 1997 (22.05.97), page 9 - page 11, figures 1-4  --	1-5
X	EP 0629424 A1 (SUMITOMO CHEMICAL COMPANY LIMITED), 21 December 1994 (21.12.94), column 11, line 39 - line 49, figures 1-3  --	1-5
X	GB 2030884 A (VUPCHT VYZKUMNY USTAV POTRAVINARSKÉ CHLADICI TECHNIKY), 16 April 1980 (16.04.80), page 1, line 100 - line 124, figures 1,2  -- -----	1-5

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

16 March 1999

Date of mailing of the international search report

17 -03- 1999

Name and mailing address of the ISA

Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Christer Bäcknert

Telephone No. +46 8 782 25 00

# INTERNATIONAL SEARCH REPORT

Information on patent family members

02/03/99

International application No.

PCT/NO 98/00355

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9718025 A1	22/05/97	SE 505662 C SE 9504121 A	29/09/97 17/05/97
EP 0629424 A1	21/12/94	AU 674214 B AU 6474494 A BR 9402422 A CA 2125792 A JP 7060009 A US 5833865 A	12/12/96 22/12/94 17/01/95 17/12/94 07/03/95 10/11/98
GB 2030884 A	16/04/80	CH 632675 A DE 2842975 A	29/10/82 10/04/80